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# Applying Technology Acceptance Model, Theory of Planned Behavior and Social Cognitive Theory to Mobile Data Communications Service Acceptance

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**Abstract**

*This study examines patterns of mobile data communications service adoption with respect to a commonly used service, short message service, at the individual users level. Based on Davis' technology acceptance model, Ajzen's theory of planned behavior, and Bandura's social cognitive theory, a comprehensive model is established to test the influence of self-efficacy, perceived usefulness, perceived ease of use, social pressure, and perceived enjoyment on mobile data communications service acceptance. The model also examines the moderating effect of perceived enjoyment on the influence of perceived usefulness on intention to use the service. An empirical study is conducted to test this model using data collected from 172 mobile data services users. The results support most of the hypothesized relationships in the model. Especially, users' telecommunication self- efficacy has a strongly positive effect on perceived ease of use, which then has significantly positive effect both on perceived usefulness and on intention to use. Perceived enjoyment and perceived usefulness both have positive effect on the intention to use. However, the moderating effect of perceived enjoyment in the model is not confirmed. Implications of these findings for practice and research are discussed.*

**Keywords**: Technology Acceptance Model, The theory of Planned Behavior, Social Cognitive Theory, Moderating Effect, PLS

## 1. Introduction

Facing the coming 3G mobile communications technology, the society is waiting for it's drastic influence on all aspects of the life as it had with the existing Internet and telecommunications technology during the past decade. Undoubtedly, the influence of any technology or service on the society has to depend on the extent to which it be accepted by the users. Even though the 2G mobile communications technology and some related services have been accepted by the popular, few academic studies have examined why they were adopted and used from the psychological and behavioral perspectives (Kwon and Chidambaram 2000). However, more and more researches were concentrated on the individual's adoption of the computing technologies in information systems (IS) discipline recently (Davis 1986; Compeau et al. 1999; Venkatesh et al. 2003). 3G's high-speed data transmitting capacity can support some new services that were not available by 2G, but whether these services can be accepted by users remains doubted. Advanced technology alone can't guarantee the users' satisfaction (Xu 2003). Oppositely, some basic data services obtained satisfactory performance, adopted and used by the users frequently, for example, short message service (SMS) is fairly successful in China during past a few years (Xu 2003). So it is necessary to study users' behavior on mobile communications services to detect what

factors are determining users' adopting behavior. This kind of study should be possible with the help of some theories and theoretical model existing in IS field, where the communications technology is belonging.

## 2. Theoretical background

Recently, a lot of study about individual reaction to information technology (IT) or systems have been conducted from a variety of theoretical perspectives, including technology acceptance model (TAM) (Davis 1986; Davis et al. 1989; Venkatesh and Davis 1996), the theory of planned behavior (TPB) (Ajzen 1985, 1989; Taylor and Todd 1995), and Social Cognitive Theory (SCT) (Compeau and Higgins 1995a, 1995b; Hill et al. 1986, 1987) etc. These theories addressed the cognitive, affective and behavioral reactions of individuals to technology and innovation, and the factors influencing these reactions.

In Davis' (1989) technology acceptance model, users' technology acceptance intention was directly affected by perceived usefulness (PU) and perceived ease of use (PEOU), which had positive effect on perceived usefulness. As he described, a user's acceptance with a technology was influenced by both intrinsic and extrinsic motivators, which included PEOU and PU respectively. Davis et al (1992) elaborated further that there should have another intrinsic motivator, perceived enjoyment (PE) to have a direct effect on users' acceptance behavior. PE was defined as the extent to which the activity of using a computer or IT was perceived to be enjoyable in its own right apart from any performance consequences.

Davis' TAM was adapted from Fishbein and Ajzen's (1975) theory of reasoned action (TRA) which explained people's actions by identifying the causal connections between some components as beliefs, attitudes, intentions and behavior. TRA was concerned with the determinants of actual and intended behavior. It illustrated that behavior was determined by a person's attitude toward behavior and the subjective norm (SN) concerning that behavior. SN referred to the social pressure exerted on the person to perform (or not) the behavior. The idea in TRA was adopted by Ajzen to establish his another theory, the theory of planned behavior (TPB) (Ajzen 1985, 1989), which considered SN a very important antecedence to the behavior. Also, TPB model incorporated the notion of perceived behavioral control as an independent influence on behavior, independent of perceived outcomes. Perceived behavioral control encompassed perceptions of resource and technology facilitation conditions, similar to self-efficacy (SE) in social cognitive theory (SCT) (Bandura 1991).

SCT emphasized the concept of SE, defined as beliefs about one's ability to perform a specific behavior, recognizing that our expectations of positive outcomes of a behavior would be vain if we doubted our capability to successfully execute it firstly. IS research has demonstrated a strong link between SE and individual reactions to IT both in terms of intention to use it and the actual usage of IT (Compeau and Higgnis 1995b). Moreover, some recent researches (Igbaria and Iivari 1995; Venkatesh and Davis 1996; Venkatesh 2000, 2003) were focused on how computer self-efficacy can influence PEOU in TAM, and most of them indicated that the former had positive effect on the later.

These theories and models have been considered some most important theoretical background for research about individual user's reaction and behavior upon IT adoption. Although they have emphases on the model constructs or theory concepts in different ways, some researches combine them to establish a derived framework in some different technology, organization, user population context. Further, some varied relationships among these constructs were found. For example, Davis et al. (1992) proposed that PE should negatively

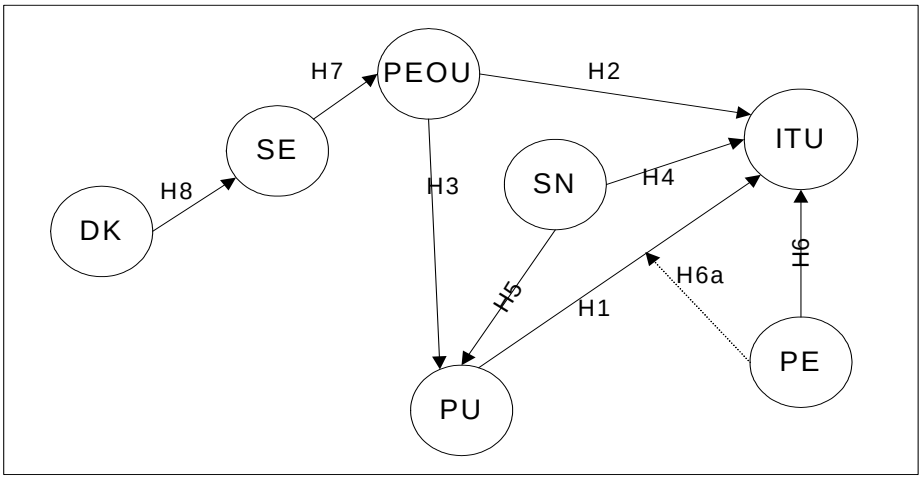
moderate the relationship between PU and adoption behavior, which had been confirmed by Chin et al. (2003) in the E-mail adoption context. Worth of notice is that Venketash et al. (2003) drew a conclusion about most of applied theories and models in IS research in the past few decades and developed a unified model, called the unified theory of acceptance and use of technology (UTAUT), which combined some core conceptions of the technology acceptance determinants in previous models and summarized them into four categories, named performance expectancy, effort expectancy, social influence, and facilitation conditions.

## 3. Research framework

The goal of this study is to examine whether these research theoretical work can be applied to a relatively newer technology context of mobile data communications service, and to detect what are determinants of adopting it from the behavioral, cognitive and affective aspects. Although few previous researches have been conducted in such way except for some computing technology, mobile communications service is actually a form of information and communications technology (ICT). It also has much similarity to computing technology, while it is more standardized and popularly used. Therefore, the users' reaction or behavior towards this ICT must be somewhat similar to that towards to IT. Actually, some research (Davis, D. M., 1993; Kwon and Chidambaram, 2000) did confirm this point. Interestingly, mobile commerce, one kind of mobile data communications service, is becoming a hot topic in IS research. So it made sense to apply some IS theories and models to study users' behavior towards ICT, particularly, mobile data communications service in this study.

Referring to what Venkatesh et al. (2003) did to establish UTAUT, we combine some core constructs from four most frequently used models, rather than eight in Venkatesh et al (2003), and establish the theoretical framework in this study. These four models are TAM, TRA, TPB, and SCT. Because TAM is adapted from TRA, and there is some conception overlapping between TPB and TRA, TRA is not considered the direct referred theory here. Specifically, in the framework PU, PEOU, PE and ITU are from TAM, and SN from TPB, and SE from SCT. Figure 1 shows the research framework in this study.

**Figure 1. Research model**




### Perceived Usefulness

Perceived usefulness (PU) was defined as the extent to which a person believed that using a particular technology would enhance his/her job performance (Davis 1989). A significant body of TAM research has shown that perceived usefulness is a strong determinant of user's

intention to use the technology (Davis 1989; Venkatesh and Davis 1996; Venkatesh and Morris 2000). In this study with respect to SMS, We propose:

***H1****: Perceived usefulness of SMS will have a positive effect on intention to use SMS.*

**Perceived Ease of Use**

Perceived Ease of Use (PEOU) was defined as the degree to which a person believed that using the system would be free from effort (Davis 1989). PEOU has effect on intention in two ways: one is the direct effect on intention and the other was indirect effect on intention via PU. The direct effect suggested that PEOU could increase the likelihood of ITU. The indirect is explained as stemming from a situation where, other things being equal, the easier a technology is to use, the more useful it can be perceived. In SMS context, we state:

***H2****: Perceived ease of use of SMS will have positive effect on intention to use SMS.*
***H3****: Perceived ease of use of SMS will have positive effect on Perceived usefulness of SMS.*

**Subjective Norm**

Subjective norm (SN) was defined as the degree to which an individual believed that people round him or her who were important to him/her thought he/she should perform the behavior in question (Fishbein and Ajzen 1975). Venkatesh and Davis (2000) introduced TAM2 and proved SN had both significant effects on PU and ITU. SMS is a popular communications service, and has network effect that means the value of the service depends on the number of people already adopted it. It is rational that these referents would be one important part of people that the privy C wants to communicate with. Therefore, we suppose:

***H4****: Social pressure will have a positive effect on intention to use.*
***H5****: Social pressure will have a positive effect on perceived usefulness.*

**Perceived enjoyment**

Perceived enjoyment (PE) represented an intrinsic motivation for use of the technology. It represents a type of intellectual playfulness and is defined as an individual characteristic that describes an individual's tendency to interact spontaneously, inventively with a technology or IT service. Davis et al. (1989) found that while PU emerged as the major determinant of computer acceptance, enjoyment and fun had a significant effect beyond PU. Davis et al (1992) elaborated further that PE should be another intrinsic motivator to directly affect on users' acceptance behavior. In SMS context, besides its function of communications, mobile communications services have become a kind of entertainment in people's daily life, especially data service. SMS is full of entertainment functions, such as downloading ring tone, music, or browsing sports news, entertainment news etc. therefore, we concern:

***H6****: Perceived enjoyment will have a positive effect on usage intention of SMS.*

Moreover, Davis et al. (1992) put up that PE should moderate the relationship between PU and ITU, which had been confirmed by Chin et al. (2003) in the E-mail adoption context. Chin et al (2003) detected that PE would negatively influence the relationship between PU and ITU. That is, when the IT using experience was more enjoyable, the impact of PU on

future ITU was lower. Conversely, the less enjoyable one perceives the IT to use, the stronger the impact of one's PU on ITU. In this study, we have the following hypothesis:

***H6a**: Perceived enjoyment of SMS will have a negative moderating effect on the relationship between perceived usefulness and usage intention.*

**Self-efficacy**

Self-efficacy (SE) was an individual's estimate of his or her capacity to perform a specific task (Gist and Mitchell 1992). SE is a key concept and a critical self-regulation mechanism in SCT (Bandura 1991). In IS research, computer self-efficacy was introduced as the judgment of one's capability to use an information technology (Compeau and Higgins 1995). Some IS research (Venkatesh and Davis 1996; Venkatesh 2000) reported that computer self-efficacy had significantly positive impacts on PEOU. Recently, Agarwal et al. (2000) further made a distinction between computer self-efficacy and software-specific self-efficacy such as Lotus 1-2-3 self-efficacy, and found a very strong positive relationship between software-specific self-efficacy and the PEOU of the software. Following the same distinction, we introduce the concept of telecommunications self-efficacy as one's estimate of his or her capability to master some telecommunications services. We state:

***H7**: The telecommunications self-efficacy positively influences perceived ease of use of SMS.*

**Domain specific knowledge**

Domain specific knowledge (DK) can be understood as the knowledge in some specific domain or subject, rather than in general field (Leary and Daniel 1996). Some research found that domain specific knowledge was one of determinants of SE. Gist and Mitchell (1992) reported there were two categories of determinants of SE, external and internal. Among the internal determinants, an individual's ability (knowledge and skills) was particularly important upon the form of his/her SE. Anandarajan et al. (2002) stated that computer-domain skills, experience and knowledge could help strengthen one's computer self-efficacy. Liu and Grandon (2002) indicated some measures, such as training or educating, could be adopted to improve computer self-efficacy of users effectively. According to these literatures, it is logical to think that more knowledge in telecommunications subject a user owns, the more telecommunications self-efficacy he or she will have. Therefore, we propose:

***H8**: The telecommunications specific knowledge will have a positive effect on telecommunications self-efficacy.*

## 4. Research design

### *4.1. Subjects*

To test our research model, an empirical study using mailing questionnaire was administered to actual mobile data communications services users in Mainland China. Subjects were some customers of one market-dominant mobile operator. We selected 300 users with stratified sampling and random sampling method (stratum being province in China) from the customers all over the China and contacted them by their registered phone numbers. 267 of them promised to participate our study, willing to complete the questionnaires that we would send them. Then their current mail addresses were confirmed.

### *4.2. Questionnaire and Construct Measurement*

We operationalized the constructs in our research model by using measurements validated by previous research with wording changes necessary for the targeted SMS context (See Appendix A for detail of measurement scales). Some question items were deleted in order to ensure the briefness of the whole questionnaire, for example, 10 items were used in the original literature for self-efficacy, and we adopted 5 of them. All question items were measured using a seven-point Likert scale ranging from "strongly disagree" to "strongly agree". All items were randomly arranged and half of them were reversely asked to reduce a potential "say-yes" response from the subjects. A pilot study was conducted among some postgraduates in the author's affiliation to test the validity of the primary questionnaire. With some necessary modification was the final questionnaire ready. Standard back-translation techniques (Brislin 1986) were used to develop Chinese language versions of the questionnaire. The back-translation process was repeated until the back-translated versions appeared to be equivalent to the English version. As an additional check, the translated instruments were independently reviewed by two authors to confirm whether each item was satisfactory in representing the items from the original English version.

### *4.3. Data collection*

In the following week, 267 questionnaires were mailed out to these participants with one research explaining and participation acknowledging letter and a postage paid envelop. Within one month afterwards were 135 questionnaires posted back. We then followed up to remind those non-respondents by phone call. Other 37 questionnaires arrived within half a month. 172 questionnaires were collected totally. The response rate was 64.4%, which was considerable in the mail survey. Maybe it was because that mobile operator would provide the respondents some bonus in terms of free mobile air. Comparing the data of these earlier respondents with that of those later respondents did not found significant differences, which can mean no response bias between the response and the non-response.

## 5. Data analysis

### *5.1. Analysis of respondents*

The respondents reported their basic information about their demographic and consumption on mobile communications (See Table 1). Of the 172 participants, 54.1% are male and 44.2% female. On average, they are around 27 years old, and most (74.4%) have an associate or higher-level education. 69.2% have used mobile communications services over two years.

**Table 1. Respondents' demographic information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Gender | Male | | Female | | | No report |
| | 93 (54.1) | | 76(44.2) | | | 3(1.7) |
| Age (Years) | <20 | 21--25 | 26--30 | 30—40 | >40 | |
| | 8(4.7) | 79(45.9) | 69(40.1) | 11(6.4) | 1(0.6) | 4(2.3) |
| Education Level | High school | Associate | Bachelor | Master | Doctor | |
| | 42(24.4) | 36(20.9) | 52(30.2) | 33(19.2) | 9(5.2) | 2(1.2) |
| Income/month (￥RMB) | <1000 | 1000--3000 | 3000--6000 | 60000--8000 | >8000 | |
| | 73(42.4) | 48(27.9) | 31(18.0) | 11(6.4) | 6(3.5) | 3(1.7) |
| Time using mobile service (year) | <1 year | 1--2 | 2--4 | 4--8 | >8 | |
| | 10(5.8) | 39(22.7) | 90(52.3) | 27(15.7) | 2(1.2) | 4(2.3) |
| Expenditure on mobile/month (￥rmb) | <100 | 100--300 | 300--600 | 600--800 | >800 | |
| | 98(57.0) | 51(29.7) | 16(9.3) | 4(2.3) | 1(.6) | 2(1.2) |

*The value given in parentheses is percentage.*

### *5.2. Measurement Validity*

We evaluated the measurement's validity in terms of internal consistency (i.e. reliability), which was examined using Cronbach's alpha value, and convergent and discriminant validity by the Exploratory Factor Analysis methods. We assessed the instrument's convergent and discriminant validity by using a principal components factor analysis of Varimax with Kaiser normalization rotation. A total of seven constructs are extracted with eigenvalues exceeding 1.0; i.e. exactly equal to the number of the constructs specified in the model. Furthermore, most of items intended to measure the same construct exhibit prominently and distinctly higher factor loadings on a single component (e.g. exceeding 0.6) than on other components, suggesting adequate convergent and discriminant validity of the instruments. After discarding those items cannot heavily load on their respective construct, we got the loading value of the rest items, which would be used in the following model testing, and the Cronbach's alpha values of all scales subsequently exceeded .70, the level deemed acceptable for exploratory research (Fornell and Larcker 1981) (see Table 2).

**Table 2: Factor Analysis Results- Rotated Component Matrix**

| Construct | Reliability (Alpha) | Component | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| PU1 | .805 | .155 | .166 | **.725** | .209 | -.063 | .136 | .167 |
| PU2 | | .177 | -.039 | **.686** | -.045 | .173 | .250 | .307 |
| PU3 | | .098 | -.026 | **.713** | -.129 | .219 | .253 | .150 |
| PU4 | | .290 | .183 | **.671** | .228 | -.027 | .210 | .280 |
| SN1 | .783 | .093 | .215 | .308 | .124 | .026 | **.718** | .134 |
| SN2 | | .206 | -.077 | .155 | .035 | .076 | **.837** | .177 |
| SN3 | | .291 | .171 | .349 | .171 | .015 | **.639** | -.058 |
| PEOU1 | .848 | .285 | **.699** | .277 | .275 | .086 | -.092 | -.123 |
| PEOU2 | | .212 | **.839** | .073 | .058 | .098 | .056 | .023 |
| PEOU3 | | .229 | **.828** | -.023 | .165 | .218 | .093 | .166 |
| PEOU4 | | .091 | **.766** | .028 | -.051 | .152 | .148 | .394 |
| PE1 | .831 | .196 | .197 | .260 | .078 | .088 | .037 | **.788** |
| PE2 | | .124 | .246 | .352 | .227 | .047 | .266 | **.678** |
| PE3 | | .402 | .054 | .333 | .070 | .083 | .175 | **.675** |
| ITU1 | .878 | **.744** | .077 | .164 | .044 | .159 | .228 | .195 |
| ITU2 | | **.799** | .228 | .115 | .064 | .097 | .089 | .155 |
| ITU3 | | **.834** | .151 | .078 | .096 | .042 | .118 | .049 |
| ITU4 | | **.776** | .227 | .217 | .134 | .037 | .098 | .170 |
| SE1 | .777 | .123 | .145 | .144 | .064 | **.813** | -.005 | .030 |
| SE2 | | .019 | .070 | .046 | .181 | **.854** | -.020 | -.013 |
| SE3 | | .127 | .245 | .012 | .198 | **.670** | .205 | .216 |
| DK1 | .854 | .062 | .051 | .155 | **.882** | .122 | .022 | .201 |
| DK2 | | .045 | -.019 | -.017 | **.853** | .152 | .149 | .029 |
| DK3 | | .219 | .280 | .017 | **.772** | .155 | .057 | -.023 |

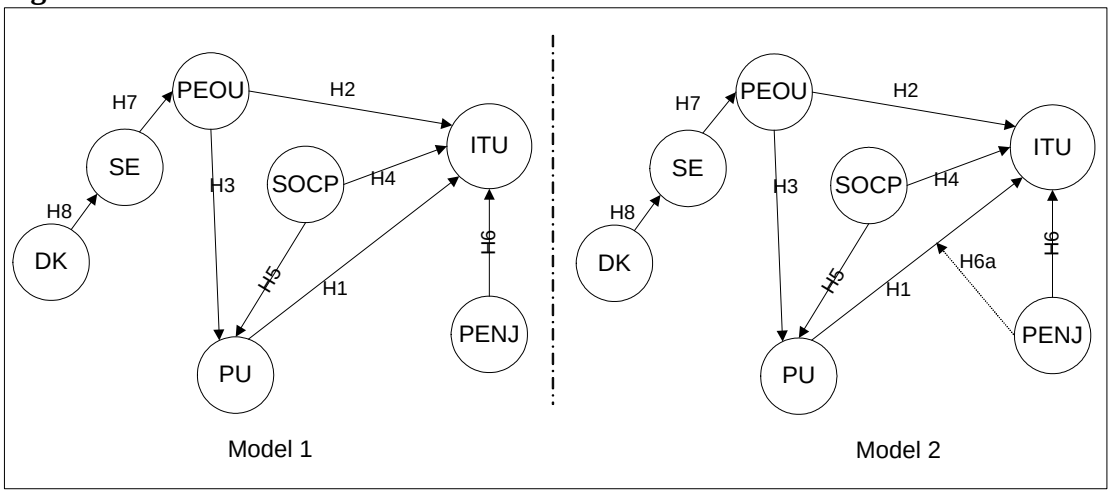
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.
a Rotation converged in 7 iterations.

### *5.3. Test of the Structural Model and Hypotheses*

The Partial Least Squares (PLS) analysis is used here to analyze the data, because it follows a components-based strategy and does not depend on having multivariate normal distribution, interval scales, or a large sample size (Fornell and Bookstein 1982; Chin and Frye 1995). The PLS is more prediction-oriented and sought to maximize the variance explained in constructs, thus makes it closer to data and more exploratory, and more data analytic (Barclay et al.

1995). Given the relatively small sample size compared with the number of variables, the PLS is more suitable for testing the structural model in this study. In order to test whether PE has moderating effect on the relationship between PU and ITU. Two steps will be conducted. Firstly the structural model without the moderating effect (Model 1) of PE would be tested, and then the moderating effect would be added (Model 2) and tested (Figure 2). Then the results of two models would be compared.

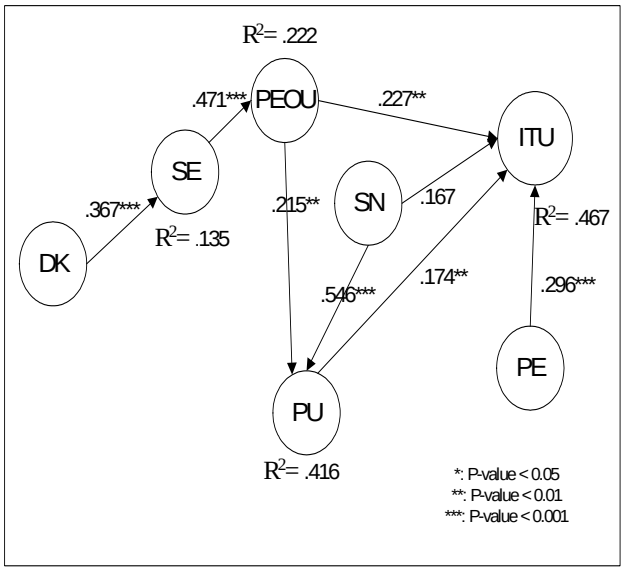
**Figure 2. Model 1 and Model 2**




The test of the structural model includes estimating the path coefficients, which indicates the positive or negative relationships between the exogenous and endogenous constructs and the strength of these relationships, and the R-square ($R^2$) value, which represents the amount of variance of the dependent constructs explained by the independent constructs. Together, the path coefficients (arbitrary value and statistical significance) and $R^2$ indicate how well the model is performing. $R^2$ indicates the predictive power of the model, and the path coefficients should be significant and directionally consistent with the hypotheses.

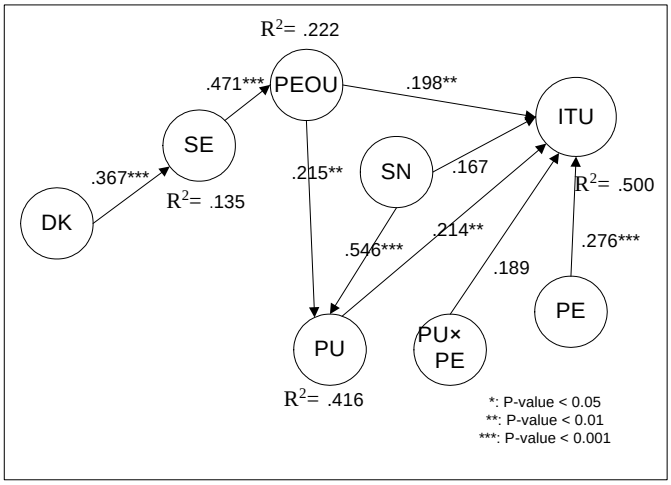
Overall, the model 1 is able to account for 46.7% of variance in the construct of intention to use (ITU), as indicated by Figure 3. Especially, PU, PEOU, and PE contribute significantly to the observed explanatory power of ITU. However, inconsistent with our hypothesis, SN does not have significant effect on the ITU directly. Despite this, SN still has its influence in the model because the result indicates that SN has significantly positive effect on PU, with the path coefficient of .546, and the P-value less than .001. At the same time, the combination of PEOU and SN account for 41.6% of the variances observed in PU, while PEOU contributes to PU less than SN, having path coefficients of .215 and .546 respectively. According to path coefficients and their statistical significances shown in Figure 3, all proposed hypotheses in Model 1 are supported except H4 about the effect of SN on ITU. While the results confirm the

**Figure 3. Model 1 Testing Result**



relationships among some main constructs in TAM, i.e., PU, PEOU and ITU, the effect of PE on ITU originally proposed by Davis et al (1992) can not be completely confirmed in this study, in terms of the magnitude's the effect. Moreover, the result cannot support the direct effect of SN on ITU as proposed in Venkatesh and Davis' TAM2 (Venkatesh and Davis 2000). Importantly, individual's self-efficacy (SE) does have a significantly positive effect on PEOU, and domain specific knowledge (DK) is one of determinants of SE. Summarily, among the determinant factors of SMS usage intention, PE has the strongest direct effect on ITU, with a path coefficient of .296, followed by PEOU with the path coefficient of .227. PU has the lightest effect on ITU in this SMS context, which is not consistent with the findings in most other IS researches while understandable.

**Figure 4: Model 2 testing result**




As stated in Hypothesis 6a that PE of SMS would have a negative moderating effect on the relationship between PU and ITU. In order to test whether PE is a negative moderator, PLS product-indicator approach (Chin, et al., 2003) is applied here to test it by detecting the interaction effect of PE on the PU – ITU relationship. In order to use PLS product-indicator approach to test the possibility of such an interaction effect, it is required of forming a new construct, interaction construct, to represent the interaction of the main construct and moderating construct. The indicators of the interaction construct can be created by multiplying each indicator of the main construct with that of the moderating construct. The result of the new model with this interaction construct will be compared with that of the original model without it to detect whether or not it should be in the model. See the paper (Chin, et al. 2003) for moderator test method with PLS in detail.

Standardized indicators are chosen for this analysis because Likert-scales have been employed in this study, so all indicators can be considered theoretically parallel. The result of Model 2 with interaction construct is shown in Figure 4.

We compare the squared multiple correlation ($R^2$) for this interaction model (Model 2) with $R^2$ for Model 1, which excludes the interaction construct. The overall effect size $f^2$ for the interaction is .07, between a small and medium effect suggested by Cohen (1988). However, the path coefficient from the interaction construct to usage intention is not statistically significant (P-value > .1), so we cannot consider that PE would have an interactive effect with PU on user's intention to use SMS, which means no moderating effect of PE existing here. Consequently, hypothesis 6a could not be supported. See Table 3 for a summary of the hypotheses testing results.

**Table 3 Hypothesis Testing Results**

| | | | |
|---|---|---|---|
| **H1** | Supported | **H6** | Supported |
| **H2** | Supported | **H6a** | Not Supported |
| **H3** | Supported | **H7** | Supported |
| **H4** | Not Supported | **H8** | Supported |

## 6. Discussions

This study examines a comprehensive model studying users' acceptance of a kind of mobile data communications service, SMS, refereeing technology acceptance model, the theory of planned behavior and social cognitive theory. Based on data collected from 172 randomly selected mobile communications service users, the utility of the postulated model for explaining users' acceptance of SMS was evaluated. The results fairly supported the proposed combined model.

With respect to the TAM part in the research model, PU still had a positive effect on users' intention to use SMS, and PEOU had both positive effects on ITU in two ways, directly on it and indirectly through its significantly positive effect on PU, which agreed with what the TAM postulated. Whereas, we found that the direct effect of PEOU on ITU exceeded that of perceived usefulness, which was not expected by TAM. Beyond the original structure of TAM, PE was confirmed having a significantly positive effect on ITU while this was not surprising actually since the possible effect of PE on users' acceptance behavior was not affirmed by Davis et al (1992). However, interesting was that the biggest path coefficient of .296 announced that PE was the strongest determinant, rather than PU or PEOU. Although these findings were not consistent with what TAM postulated and most of other IS research detected (Anandarajan 2002), it was rational in the SMS context.

In our study, we attribute these disaccords as a result of the unique characteristic of SMS from other information technologies or systems. As a basic while technologically mature mobile data communications service, SMS's usefulness and functionality must have been recognized by users. Simultaneously, users are considering SMS an entertainment way, such as using SMS to download music, or to exchange greeting words and adult humors etc (Xu, 2003). Users might have a higher concern about SMS's enjoyableness other than its actual communications functionality. The more joyful using SMS is, the more positive the attitude of the users will be towards it. Therefore, PE becomes a dominant concern determining the users' ITU. Moreover, as SMS is a simple service and used by mobile users in any possible circumstance, its functionality and usefulness in people's daily communications have been understood fully. The easier and more convenient the service is and the less the time the users need to handle it, the more possible that the users will use it. Therefore, PEOU becomes more important on users' ITU than PU does.

It is worth to notice that domain specific (telecommunications) self-efficacy shows a strong direct effect on PEOU. Judged by the model test result, the path coefficient between it and PEOU is the second biggest in the whole model, this is logically understandable. Since telecommunications specific self-efficacy is a kind of individual confidence in his or her capability to complete a task in the telecommunications field that seemly contains intensive high-tech. Such confidence will have a direct and strong impact on the perception on ease of use intuitively. Furthermore, we find that there is positive relationship between domain specific (telecommunications) knowledge and domain specific self-efficacy. It is also understandable because mobile communications was a new science subject, and people's knowing and capability in this area mainly come from their postnatal learning and education. So more knowledge one owns in this specific subject, more confident he or she will feel to do related task in this subject. Additionally, the finding about the role of subjective norm in this context is not harmonic with our hypothesis to some extent. Although it has no significant direct effect on the intention to use SMS, its effect on perceived usefulness is prominent with the largest path coefficient in the model. Because perceived usefulness has been confirmed to have significantly positive effect on intention to use, subjective norm can influence users'

usage intention indirectly. As analyzed earlier, it is the network effect of the mobile communications services that makes subjective norm has so momentous influence on users' perceived usefulness of SMS. As detected in model 2, perceived enjoyment has no negative moderating effect on the effect of perceived usefulness on usage intention, which means perceived enjoyment cannot displace perceived usefulness, vice versa. So service operators must ensure them both in their provided service simultaneously.

These findings have some significant implications to the mobile communications industry in the real world. It indicates that in order to facilitate users' mobile data services acceptance, it is crucial to increase their perception on the services' enjoyableness and ease of use simultaneously. Certainly, perceived usefulness should be guaranteed firstly since the functionality was the most basic foothold for a mobile communications services. At the same time, improvement in users' telecommunications specific self-efficacy can enhance their services acceptance through promoting their perceived ease of use. When a new mobile data communications service, such as multimedia service or Internet browsing of 3G mobile communications, is introduced, in order to motivate popular users' proactive acceptance of the service it is necessary to provide a variety of features to prompt users' perceived enjoyment; it is also necessary to provide a user-friendly mobile handset-human interactive interface to increase perceived ease of use. Additionally providing the potential users some lecture or demonstration about mobile communications related knowledge could improve their specific self-efficacy, and then increase their perceived ease of use. Last but not least, subjective norm is playing a very unique role on determining users' behavior on the mobile data service adoption. Different from some IT systems used in a corporate or institutes with a relatively limited scope in terms of geographic location and the number of users, mobile data communications service should be used by a giant group of people. It has the nature of network effect so its actual utility shall be decided by the number of the users in a large degree. The important effect of subjective norm on users' perceived usefulness should grasp the attention of the mobile service operators. For example, "words of mouth" can have a significant influence on one's perception about a certain service's usefulness. Furthermore, since we cannot affirm the negative moderating role of the perceived enjoyment in the model, and even we get a positive path coefficient from the interaction construct to users' intention (while not statistically significant), it possibly implies that perceived enjoyment and perceive usefulness of a mobile communications service can substitute each other. That mean we cannot ignore either of them.

## 7. Limitations and conclusions

This empirical investigation of the proposed comprehensive research model has several limitations. Firstly, there are numerous factors affecting the acceptance of mobile data communications service, such as the price, but in our study we just focused on some factors that were from TAM, TPB and SCT, not from economics theory. However, being a personal commercial commodity, whether mobile data communications can be used by consumers will depend on the ratio of performance (or usefulness) to its price (or cost) to some substantial extent, so neglecting the effect of economic factors on the consumption of the service maybe has mitigated the explaining capacity of the model. In the further research, we shall integrate them into the model. Secondly, the mobile data service of this study was specified to SMS, a very basic and easily operating service, but maybe it is not representative to some other services. More studies need to be done in order to generalize our findings to a wider scope of service domains. Thirdly, as the survey was conducted with the self-reported method, it is hard to know how accurately these self-reports can reflect user's actual behavior. It may also, to some extent, cause common method variance (CMV) (Kline, et al., 2000). The Multi-Trait

Multi-Method should be adopted in the future research in order to avoid this kind of CMV (Bagozzi and Yi, 1990). Fourthly, in order to test a technology used in the whole society scope, the sample size of 172 is too small since there are only about 10 subjects scattered in each province, which will raise some doubt about the sample's representativeness. Moreover, the sample's distribution in terms of education level and age seems not to be even enough, which will be worthy checking in the further research. Together, these possible biases would bring out the questions about the validation of the research results, especially about that we cannot affirm the moderating effect of perceived enjoyment in the model.

Overall, this study provides a better understanding of the individual user's acceptance decision making for a mobile communications service, in a little different domain from IS. The findings are achieved on the basis of a comprehensive model TAM, TPB and SCT. The results support most of our hypotheses and the findings are of great implications to the business operation in mobile communications service areas. Nevertheless, further research should be carried out in a universal mobile communications service context, with bigger subject sample in order to expand the generalizability and applicability of this comprehensive model.

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## *Appendix A: Measurement scales*

Following are measurement scales for each construct. They are referred from the original sources noted in the parentheses, but SMS is substituted for the technologies in the origins.

**Domain specific knowledge (DK)** (source: Leary and Daniel 1996)
DK1: I think that I have mastered a lot of telecommunications related knowledge.
DK2: I think that I have some knowledge about the mobile communications.
DK3: I understand some basic principles of telecommunications technologies.

**Perceived usefulness (PU)** (source: Davis et al., 1989)
PU1: Using SMS services improves my communications quality.
PU2: Using SMS services makes it easier for me to communicate with others.
PU3: Using SMS services improves the functionality of mobile communications.
PU4: SMS is useful in my life.

**Perceived Ease of Use (PEOU)** (source: Davis et al., 1989)
PEOU1: Learning to use SMS services to communicate with others is easy for me.
PEOU2: I find it easy for me to use SMS services to transmit information.
PEOU3: My interaction with SMS would be clear and understandable.
PEOU3: Overall, I find SMS services easy to use.

**Perceived Enjoyment (PE)** (Source: Davis, et al. 1992)
PE1: I find using SMS to be enjoyable
PE2: The actual process of using SMS is pleasant.
PE3: I have fun using SMS.

**Self-Efficacy (SE)** (source: Compeau and Higgin, 1995a & 1995b)
SE1: I could complete the task using some telecommunications service if I had seen someone else using it before trying it myself.
SE2: I could complete the task using some telecommunications service if I had a lot of time to be familiar with the service.
SE3: I could complete the task using some telecommunications service if I had used similar service before to do the same job.

**Subjective Norm (SN)** (source: Taylor and Todd, 1995)
SN1: My friends would think that I should use SMS to communicate with others.
SN2: My colleagues would think that I should use SMS to communicate with others.
SN3: People who influence my behavior would think that I should use SMS to communicate with others.

**Intention to Use (ITU)** (source: source: Davis et al., 1989)
ITU1: I intend to use SMS service to communicate with others when possible.
ITU2: I intend to use SMS service to communicate with others as often as needed.
ITU3: I intent to use SMS service to do job-related or entertaining work.
ITU4: To the extent possible, I would use SMS service in my daily life frequently.